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ABSTRACT

Developed to assist teachers in the teaching of outdoor biology and ecology, this guide contains lessons that can be conducted in an urban environment for elementary level students. Each lesson begins with thought-provoking introductory questions which lead into the actual activity, and concludes with discussion questions and suggestions for additional activities. Major sections address the topics of: (1) surveying the site (including introductory activities on the environment, soil, and water); (2) plants in the city (containing lessons on trees, weeds and grass, small plants and experiments with plants); (3) animals in the city (focusing on birds, insects, mammals, and animal adaptations); and (4) studying and building communities (consisting of activities with aquaria, terraria, mini-habitats, and local ecosystems). (ML)

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Teaching Nature in Cities and Towns

Sonia Wolff Vogl

Robert L. Vogl

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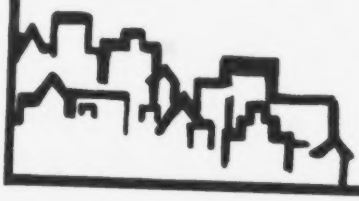
Sonia Wolff Vogl, Ph.D.
Associate Professor
Northern Illinois University

Robert L. Vogl, Ph.D.
Associate Professor
Northern Illinois University



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Introduction

This book is a guide to teaching outdoor biology and ecology at the elementary level. It contains lessons that can be handled by teachers in the setting in which they teach: the urban environment. It is designed to be used at all levels of the elementary school. The suitability of details (measuring, charting, vocabulary development, etc.) to the class's abilities should be evaluated by the individual teacher.

Each lesson begins with thought-provoking introductory questions which lead into the actual activity, and concludes with discussion questions as well as suggestions for other activities which could be used in conjunction with the one chosen.

Although lessons are categorized and arranged somewhat sequentially, each is designed to stand independently and can be used out of sequence whenever needed.

Lessons can be conducted with few available materials.

Contents

Chapter		Page
	Part One: Surveying the Site	
1	Introductory Activities: The Environment	1
	Cycles in Nature, 3	
	Mapping the School Yard, 4	
	School Yard "Sundial," 6	
	Sunlight and Temperatures, 7	
	Environmental Conditions Around the School Building, 8	
	Temperatures Around A Building, 9	
	Micro-climates, 10	
2	Soil and Water	11
	Erosion on the School Grounds, 13	
	Soil Percolation Testing, 14	
	School Site Watershed (Rainy-Day Activity), 15	
	Streams in the Street (Rainy-Day Activity), 16	
	Part Two: Plants in the City	
3	Overview	17
	Seasonal Changes in Plants, 19	
4	Trees	21
	School Yard Trees, 23	
	Tree Blossoms, 24	
	Tree Productivity, 25	
	Trees and Their Environments, 27	
	Trees and Street Lights, 28	

Chapter Page

5 Weeds and Grass 29

Where Weeds Grow, 31
Weeds in a Crack, 32
Plant Distribution Patterns, 33
Weed Habitats and Diversity, 34
Succession on the School Lawn, 35
Plant Growth in Trampled Areas, 36

6 Small Plants 37

Seeds and Sprouts, 39
Looking for Sprouts, 40
Moss Measurement, 41
Moss Forms, 43

7 Experiments with Plants 45

The Effect of Light on Grass, 47
Fertilizing Aquatic Systems
(Rainy-Day Activity), 48
The Effect of Light on Plant Growth
(Indoor Activity), 50

Part Three: Animals in the City

8 Overview 51

Wildlife Hike, 53

9 Birds 55

Basic Bird Observation, 57
Symphony of the Birds, 58
Birds Prepare for Winter, 59
Bird Behavior at Feeders, 60
Nesting Birds, 62

10 Insects and Other Small Animals 65

Sidewalk Wildlife, 67
Insect Distribution Patterns, 68
Activity in an Anthill, 69
Insects and Flowers, 71
Collecting Caterpillars, 72
Insects Prepare for Winter, 73

Chapter | Page

Where Insects Hide in Winter, 74
Daddy-Longlegs, 75
Earthworms in the Area, 76

11 Mammals 77

Mammals Prepare for Winter, 79
Mammal Activity in Winter, 80

12 Adaptation 83

Animal Camouflage and Protection, 85

Part Four: Studing and Building Communities

13 Building Mini-terrariums and Mini-aquariums 87

Making Mini-terrariums and Mini-aquariums, 89

14 Communities 91

Mystery Aquariums, 93
Mystery Terrariums, 94
Tree Wildlife, 95
Animals Use Trees, 96
Mini-habitats, 97
Pond in a Puddle, 98
Food Chains in the School Yard, 99
Local Ecosystems, 101

Part One

Surveying the Site

Chapter 1

Introductory Activities: The Environment

CYCLES IN NATURE

Objective:

To discover the pattern of nature's changes.

Materials:

Paper and pencil

Introductory questions:

When do changes take place in nature?
Do they take place at predictable times, or at random?

Procedure:

During the entire school year, observe and record changes as they take place in nature. Include:

- Birds gathering to migrate
- Geese flying in flocks
- Squirrels hiding nuts
- Leaves turning color
- When crickets are last heard
- First frost
- First snow
- Changes in air temperature
- Changes in the sun's elevation and hours of daylight
- When the days become longer
- When the first birds (according to species) return
- When snow completely disappears
- When trees leaf out
- First flying insect
- When flowers bloom

This information in called phenological data.
Discuss information obtained.
Note that spring and fall are often the reverse of each other.

Discussion questions:

When did changes take place in nature?
Did spring and fall seem to be the reverse of each other?
Do these changes seem to make sense in their timing?

Follow-up:

Continue to collect data over a period of several years.
Organize into categories such as birds, insects, plants.
Chart phenological data.
Predict when changes will take place.
Check the validity of predictions.

MAPPING THE SCHOOL YARD

Objectives:

To learn basic mapping skills.
To prepare a map of the school yard.

Materials:

Graph paper
Paper and pencil
Measuring devices (e.g., tape, meter or yard stick)
Compass

Introductory question:

How can the class make a map of the school yard to show where things are in relation to each other?

Procedure:

Determine the scale:

Measure the outside dimensions of the school yard.

To calculate the scale, divide the measurements of the area to be mapped into the size of the paper to be used.

Example: If the area to be mapped is 200 yd. x 250 yd. (or 200 m x 250 m)*, and the graph paper is 8-1/2" by 11" (21.6 cm x 28 cm), divide 11" by 250 yd. (28 cm by 250 m). The result will be slightly more than 1/4" (1 cm) of paper for each yard (meter) of school yard. Therefore, the scale to use would be 1/4" : 1 yd. (1 cm : 1 m).

If necessary, tape several pieces of graph paper together to have a large enough scale or large enough map.

Plot the outside dimensions of the school yard on graph paper.

Locate major features in the school yard by either of these methods:

Using a compass: Choose one corner as a base site. From this site, take a compass reading on the object to be placed on the map. Measure the distance from the base site to the object. Make a similar compass reading on the map, and measure and mark the correct distance in that direction. This spot is where the object should be located on the map.

---

*Although a meter is not equivalent to a yard, for convenience in measuring where exact size is unimportant or for the hypothetical examples, even meters/yards will be specified, i.e., 200 yd. (or 200 m). The or will be omitted where actual equivalents are used.

Using intersecting radii: Measure the distance from one corner of the school yard to the object. Mark that distance on the map with an arc. Do the same from another corner. The point at which the two lines intersect is the location of the object.

Make several readings to locate large objects, such as the school building.

Discussion question:

Does the map present an accurate visual picture of the school yard?

Follow-up:

Prepare multiple copies of the map.

Use with activities requiring a map.

Obtain aerial photos or maps of the immediate area.

Locate well-known landmarks.

Obtain city and state maps. Draw analogies between these maps and the school yard map.

SCHOOL YARD "SUNDIAL"

Objectives:

To follow the path of the sun throughout the day.
To measure lengths and angles of shadows during the day.
To develop an understanding of the use of sundials for telling time.

Materials:

Chalk

Introductory question:

How do sun shadows change during the day?

Procedure:

Have students work with partners.
For several days, have partners measure each other's shadow at least three times daily.
Mark a spot where they will stand for measurement.
With chalk, mark the end of the shadow for each measurement.
Note changes in length and direction of the shadows.
Mark shadows of stationary objects during shadow sessions.
Discuss findings with entire class.
Have the entire class choose a stationary object to serve as their shadow marker. Use a flagpole, a basketball hoop, a street light, or a street sign. Be sure the object is in an open area where its shadow falls on flat ground during the entire day.
Hourly draw a line the length of the shadow, mark the end, and write the time of observation, using chalk (or paint, if permitted).
At the end of the day, measure angles between marks. (The angles should be the same, or nearly so.)
Note how the shadow grows shorter during the middle of the day and longer in the early morning and late afternoon.

Discussion questions:

How do shadows change during the day? in direction? in length?

Follow-up:

Return to the marked shadows after a few days. If you did not know what time it was, could you tell by the position of the shadow? This is a primitive sundial.
Read about the use of sundials to tell time.
Make a sundial.

SUNLIGHT AND TEMPERATURES

Objectives:

To become increasingly aware of the sun's effect on the environment.
To measure and record a major factor of the weather.

Materials:

Thermometers
Pencils and paper

Introductory questions:

When does the sun shine on the classroom side of the school building?
Does the sun warm the building?
After the sun leaves this side of the building, does the temperature change? How quickly does it change?

Procedure:

Record when the sun first hits the east, south, and west sides of the school building.
Record the time at which the sun no longer hits each of the sides of the building.
Make and record hourly temperature measurements on each side of the school building.
Chart the data on two transparencies.
Superimpose the transparencies to form a composite picture of sunshine and temperature.

Discussion questions:

Did the temperature change (rise) after the sun hit a particular side of the school building? How quickly did it change (rise)?
Did the temperature change again (fall) after the sun no longer shone on that side? How quickly did it change (fall)?

Follow-up:

Follow with "Micro-climates," "Mini-habitats," and "School Yard 'Sundial.'"

ENVIRONMENTAL CONDITIONS AROUND THE SCHOOL BUILDING

Objectives:

To discover differences in environmental conditions around the school building.
To relate environmental conditions to plant and animal life found.

Materials:

Thermometer
Hygrometer
Flags for wind currents
Light meter (optional)

Introductory questions:

How do temperature, humidity, and winds vary around the school building?
Where are small animals (e.g., insects and daddy-longlegs) found?
Where is animal life the densest?
Where are animals the most active?
Do plants grow on the building? If so, where do they grow?

Procedure:

Within the first 2 yd. (or 2 m) above the ground on each side of the school building, mark out manageable units of measurement (e.g., a square yd. (sq m) or an area 10 yd. (10 m) long by 1 yd. (1 m) high), or establish teams of three students per linear yard (meter) to cover the entire building.
Measure and record temperature, humidity, wind, and light conditions. Use flags to indicate wind direction.
Measure wind speed with a wind vane, which can be homemade.
Record measurements on the map the class made of the school grounds. If possible, record on transparent material to produce overlays.
Combine overlay charts. Is there a visual relationship?
Observe hourly. Record when the sun hits a side of the building, and when it is gone.
Observe and record small animals (e.g., insects, spiders, daddy-longlegs). Where are they found?

Discussion questions:

Do environmental conditions vary on different sides of the school building?
Do varying conditions seem to be affected by sunlight?
Is there a relation between the appearance of small animals and environmental conditions?

Follow-up:

Follow with "Micro-climates" and "Mini-habitats."

TEMPERATURES AROUND A BUILDING

Objective:

To discover how weather conditions vary at different elevations.

Materials:

Thermometer
Wind vane
Anemometer
Paper and pencil

Introductory question:

Are weather conditions the same all aound the school building at different elevations?

Procedure:

Take temperature and wind readings for the first floor and either the second floor or the roof of the school building. Be sure to take measurements at the same time.
Compare readings.

Discussion questions:

Do weather conditions vary with elevation?
Where is the weather warmer? windier?

Follow-up:

Compare weather changes around the school building to those on a mountain. How do they differ?
Follow with "Micro-climates" and "Mini-habitats".

MICRO-CLIMATES

Objectives:

To measure climatic differences throughout a school yard.
To observe relationships between measurements such as temperature, humidity, wind, and light.

Materials:

Thermometers
Hygrometers
Wind vanes

Introductory question:

How do temperature, wind, and humidity vary throughout the school grounds?

Procedure:

Take temperature, wind, humidity and light readings throughout the school grounds.
Carefully record each reading and where it was taken.
Plot each reading on a transparency laid over the school yard map.
Draw a line joining the locations with the same temperature; next, draw lines for other temperatures at 1° intervals.
On a separate transparency repeat the process at 5% intervals for humidity, and 5 mph. intervals for wind speed. These intervals are called isobars.

Discussion questions:

Where are the highest readings found? the lowest?
Are there any observed relationships between various readings?

Follow-up:

Read daily weather maps in the newspaper and interpret isobars.
Follow with "Mini-habitats."

Chapter 2

Soil and Water

EROSION OF THE SCHOOL GROUND

Objectives:

To discover the difference in runoff speed between bare and plant-covered ground.
To understand why plants are necessary to protect soil.

Materials:

Paper and pencil

Introductory questions:

What happens to bare dirt during a rain?
How can this damage be stopped?

Procedure:

Observe and record where children walk at sidewalk corners. Do they stay on the walks or do they cut corners? What has happened to these corners? Is there less grass there than in other areas of the school lawn?
During a rain, observe what happens to the soil in bare, trampled areas. Does it erode more readily than ground that has plant cover?

Discussion questions:

Do bare areas erode more readily than plant-covered areas?
How can these areas be protected?

Follow-up:

Devise means (e.g., planting shrubs) of protecting eroded areas.
Follow with "Plant Growth in Trampled Areas."

SOIL PERCOLATION TESTING

Objectives:

To compare the water-holding capacity of soils that differ as a result of the ways they are used (e.g., eroded, protected).
To compare plant growth in different areas.

Materials:

Large can, 28 oz. (approximately 2 l) or larger, with both ends removed
Jug of water
Watch with a second hand

Introductory questions:

Will the soil that has been treated differently (e.g., walked on, trampled, left alone) hold different amounts of water?
Will this capacity affect plant growth?
Does constant traffic over an area change its water-holding ability?

Procedure:

Choose several areas that have been treated differently and that appear to be different (e.g., lawn, eroded area, path).
Set the can on the soil. Be sure that the entire cut end is touching dirt.
Slowly pour water into the can until full.
Record the amount of time required for the can to empty.
Repeat for each site chosen.
Count and compare plants in each location.

Discussion questions:

Which soil held the most water?
Did the ground that is frequently walked on hold more or less water than the others, such as lawn? (Less)
Does water-holding capacity seem to affect the number of plants that can live in an area? (More will live in porous soil than compacted; less will live in gravelly soil than rich soil or lawn.)

Follow-up:

Add measured amounts of sand, vermiculite, potting soil, etc., to school yard soil. Test for water-holding capacity.
Discuss how water-holding capacity varies.
Follow with "Plant Growth in Trampled Areas."

SCHOOL SITE WATERSHED

(Rainy-Day Activity)

Objectives:

To recognize that rain runoff is affected by soil compaction, cover, and other factors.
To develop a concept of watersheds, both immediate and far-ranging.

Materials:

Small floating objects (e.g., plastic boats, ping-pong balls)
Paper and pencil

Introductory questions:

What happens to rain after it falls?
Where does rain go that does not soak into the ground?

Procedure:

On a rainy day, follow the watershed of the school yard.
Ask questions such as:
- What happens to rain that falls on the school building? Follow it through the drainpipes.
- Where does the rain go next? Follow it through the gulleys, across the lawn, and down pathways.

Use small floating objects to follow water flow. Discuss questions such as:
- Where does the water flow fastest?
- Where does it seem to soak it?
- What happens to rain when it leaves the school yard?

Discussion questions:

Does the rain runoff flow at the same speed everywhere?
Does erosion follow regular, predictable paths?

Follow-up:

Make an overlay for the class's map of the school yard tracing rain runoff pathways.
Extend into a study of the neighborhood watershed. Where does water go from there? Trace its pathway through local rivers and eventually to the ocean.
Write rain songs.

STREAMS IN THE STREET

(Rainy-Day Activity)

Objective:

To observe the streamlike action of water flowing in a street.

Materials:

Magnifying lens (optional)

Introductory question:

How is water flowing down a street like a stream?

Procedure:

After a rain, follow a stream of water flowing in a street. Answer questions such as:

- Where does the stream come from?
- Where does the stream go?
- Is the stream carrying dirt and debris?
- Does the stream contribute to erosion?
- Do large animals drink from the stream?
- Do small animals live in the stream?

Discussion questions:

Does a street stream move dirt and debris?
Is a street stream home for small animals?
Does a street stream help larger animals?

Follow-up:

Return after another rain. Observe action of the stream as well as any changes in it.
Follow with "Pond in a Puddle."

Part Two

Plants in the City

Chapter 3

Overview

SEASONAL CHANGES IN PLANTS

Objectives:

To observe seasonal changes in plants.
To compare plants to each other in their timing of events.
To discover predictable patterns in nature's changes.
To maintain records over a period of time.

Materials:

Paper and pencil

Introductory questions:

Do all plants change in similar ways throughout the season?
Do different kinds of plants change at different times?

Procedure:

Throughout the year, observe and record changes that occur in plants in general and in specific plants the class chooses to observe.
Choose at least three different kinds of trees. Observe and record when:
- Leaves change color
- Seeds appear
- Seeds are shed
- Leaves fall
- Buds are evident in fall
- Buds swell in spring
- Plants leaf out
- Plants flower
- Seeds first appear

Observe these changes on other available plants.

Discussion questions:

Do most trees change in the same ways?
Do they go through the changes at similar times?
Are changes in plants fairly predictable?

Follow-up:

Observe plant changes over a period of several years.
Keep records and compare data from different years.
Note that in the same kind of plant, changes should be regular and predictable.

Chapter 4

Trees

SCHOOL YARD TREES

Objectives:

To become aware of differences in trees throughout the entire year.
To be able to identify trees throughout the seasons.

Materials:

Tree identification books
Pencil and paper
Crayons
Contact paper for "laminating"

Introductory questions:

What kinds of trees grow in the school yard?
How can we identify trees throughout the seasons?

Procedure:

At any season do the following activities with school yard trees:

- Contour drawings: Have each student follow in the air with one hand the major lines of a tree. With a pencil in hand, again follow the major lines of the tree. Be sure that the pencil is touching the paper. It is not necessary to look at the paper when contour drawing.
- Bark-rubbing: Place a piece of paper on the bark of a tree. Gently rub a crayon or soft pencil from side to side to produce a visual image of the bark's texture.

During the winter, sketch a twig and its buds.

During the growing season, collect leaves, press them until dry, and laminate between two pieces of contact paper. Place the name of the tree on one side, and information about the tree on the other. Use as flash cards.

Collect data on these trees from observation or books, including:

- Leaves: simple or compound
- Veins: pinnate or palmate
- Margins: toothed, lobed, smooth
- Branching, placement of leaves/buds: alternate or opposite

Develop a key to school yard trees. Begin with teams developing their own keys; exchange and use; evaluate and revise.

Discussion questions:

What trees were found in the school yard?
What techniques were used to identify trees?

Follow-up:

Develop a booklet on trees for other students to use.
Prepare a bulletin board with a key to trees.

TREE BLOSSOMS

Objectives:

To learn that most trees flower.
To recognize a diversity of flowers, including those that are small and obscure.

Materials:

Tree identification books
Magnifying lenses
Paper and pencils
Coloring equipment (e.g., crayons, pastels)

Introductory questions:

Do all trees flower? We know that fruit trees do, but do elms, oaks, and others? (All of these trees have seeds.)
If a tree has seeds or fruit, must it first have flowers?

Procedure:

In fall, locate one of each of the following trees (if available): elm, maple, box elder, oak, and walnut.
In January or February, observe each tree weekly.
As buds swell, increase the frequency of observations to twice weekly and then daily. When buds open, the flowers will appear before the leaves do.
Sketch the flowers twice weekly during their blooming period. Black and white illustrations are best for detail, but color may be added. Some trees, such as silver maple, have especially colorful flowers.
Identify the parts of each flower. Do they have pistils? stamens? petals and sepals?
Gently shake stamens to remove some pollen. What color is it?
After the flowers finish blooming, observe the ovary (bottom part of the pistil) developing into a seed. Oaks and walnuts will mature seed in fall, but the seed of elms, box elders, and silver maples will mature and drop later in the spring.

Discussion questions:

Do all seed-bearing trees have flowers?
Do all of these flowers look like flowers we're familiar with?

Follow-up:

Prepare a bulletin board of tree flowers. Post enlarged illustrations of the flowers observed.
Have a contest for the rest of the school to identify the posted flower pictures.

TREE PRODUCTIVITY

Objectives:

To discover potential tree productivity.
To discover actual tree productivity.
To discover the relationship between potential and actual tree productivity.

Materials:

Tree identification book
Measuring device (e.g., hoop, clothes hanger, tape, meter, or yard stick)
Paper and pencil

Introductory questions:

How many young trees is each tree capable of producing annually?
What would happen if all of the young trees lived to maturity?
How many actually live to maturity?
What happens to the others?

Procedure:

Locate a box elder or elm tree.
Watch it carefully in March and April, when it will flower and produce seeds.
When seeds fall, randomly choose several sites to study.
Use a hoop, clothes hanger bent into a circle, or other device to mark plots.
Count the number of seeds found in each plot. Find the average and record.
When seeds sprout, count the number sprouted, find the average, and record. Seedlings can be positively identified when the second set of leaves, the "true leaves," appears. These will look like the leaves of the mature trees.
In the fall, return to the same site. Again, count the number of seedlings per plot, find the average per plot and record. Note that this may be done as an introductory activity in the fall and followed by a spring count of seeds.

Discussion questions:

How many seeds were found in an average plot?
How many seeds sprouted?
How many sprouts lived until fall?

Follow-up:

Discuss what would happen if all seedlings matured.
Predict how a site would look in 1, 2, or 10 years if all seeds

sprouted and survived. How many seedlings must grow to maturity to replace existing trees?

Collect seeds or seedlings. Plant one for each student. Have students take their seedlings home over the summer to care for them. In the fall, use them to create a school forest.

Collect acorns. Grow them and reforest the school yard.

Locate places where trees would be an asset or enhance the view.

Follow with "Seeds and Sprouts."

TREES AND THEIR ENVIRONMENTS

Objective:

To learn how trees adapt to their environments.

Materials:

Paper and pencil (optional)

Introductory questions:

Do all trees grow in the same ways?
How do trees grow or respond if they are damaged or live with competition?

Procedure:

Observe school yard trees.
- Where are they planted?
  - In the open?
  - Near a building?
  - Along a sidewalk or street?
  - On the shady side of the school?

Discuss what environmental influences (including human) they must endure.
- Wind?
- Shade?
- Traffic?
- Other trees?
- Road salt in winter?

Discuss how they have adapted to environmental conditions.
- Growth away from competition?
- Growth on the leeward side?
- Filling in where branches have broken off?
- Losing leaves sprayed with street salt and growing on the opposite side to compensate?

Discussion question:

How do trees adapt to their environment?

Follow-up:

Decide what should be done to protect trees from damage. Implement the plan.
Read about trees growing in adverse conditions (e.g., at timberline, along the ocean).

TREES AND STREET LIGHTS

Objective:

To discover the effects of long periods of light on trees.

Materials:

Paper and pencil

Introductory question:

How does light affect the timing of trees' natural activities?

Procedure:

Locate several trees that are directly under street lights and several of the same species that are not.
Observe and record dates at which they leaf out, bloom, and drop their leaves.

Discussion questions:

Did trees under street lights leaf out, bloom, or drop their leaves earlier or later than the others?
What seems to be the effect of light on plant activity?

Follow-up:

Force plants (e.g., violets or marigolds) to bloom indoors by varying the amounts of light they receive.
Read about the effects of changing plants' biological timing.
Follow with "The Effect of Light on Grass".

Chapter 5

Weeds and Grasses

WHERE WEEDS GROW

Objectives:

To clarify the definition of the term weed.
To recognize and appreciate the importance of weeds in nature's balance.

Materials:

Paper and pencil

Introductory questions:

What is your definition of the term weed?
What good are weeds?

Procedure:

Define the term weed.
List some weeds that might be found around the school.
Working in small teams, carefully scout the school yard looking for weeds. Instruct each team to list each weed found and where it was found.
Compile data when finished with field work.

Discussion questions:

Which kind of weed was found in the greatest number of places?
Why can weeds grow in so many places?
What service do they seem to be providing? (Refer to "Plant Growth in Trampled Areas.")
Can you now change or add to your definition of the term weed?

Follow-up:

Follow with "Succession on the School Lawn" and "Plant Growth in Trampled Areas."

WEEDS IN A CRACK

Objectives:

To discover weeds in a sidewalk crack.
To determine which weeds are most abundant.
To learn why certain plants can survive adverse conditions.

Materials:

Paper and pencil
Hand lenses (optional)

Introductory questions:

Did you ever realize that when you avoid stepping on a sidewalk crack, you are saving many tiny, sturdy plants?
What plants are they? Why do they live in such a place?

Procedure:

Carefully observe a plant growing in a sidewalk crack; describe it.
- How does it look and feel?
- What is its growth pattern, flat or upright?
- How much space does it have to grow in?
- How does it get what it needs to live? (Air and sun through the leaves; water through the small soil area.)

Sketch it.
Have each student or small team "adopt" a plant and learn to identify that particular plant. Tell them to count the total number of their "adopted" plants in the sidewalk cracks in one city block or around the school block. If students working individually choose the same plant, find the average number for that species.
Pull only one sample of each plant for the entire class to study.
Place each on tagboard and label with the number found. Observe similarities between leaves.
Next, observe differences between leaves. Can plants be identified by their leaves?
Cover leaves and observe similarities and differences between roots. Can plants be identified by their roots too?

Discussion questions:

What do sidewalk weeds have in common? structure? roots? just the ability to live under adverse conditions?

Follow-up:

Define a weed. Do students have a new attitude toward weeds?
Write a story of what it might be like to be a weed trying to live in a sidewalk crack and frequently being stepped on.
Find similar weeds in other places--school yard, field, vacant lot.

PLANT DISTRIBUTION PATTERNS

Objectives:

To observe and record plant distribution patterns.
To recognize differences between distribution patterns of wild and cultivated plants.

Materials:

Steel measuring tape
220-meter string
40 small stakes
Paper and pencil

Introductory questions:

How are wild flowers distributed in nature?
Do garden flowers have the same distribution patterns?

Procedure:

Using the measuring tape (string) mark a 10 yd. (or 10 m) square plot on the lawn.
Prepare a grid within the plot by inserting stakes at 1 yd. (or 1 m) intervals. There will be 100 plots of 1 sq. yd. (or 1 sq m) within each large plot.
Count dandelions in each plot and record in the corresponding square on graph paper.
Describe the distribution pattern recorded on the graph paper. (It should be random--no apparent pattern.)
Obtain permission to study a flower or vegetable garden. Choose a garden that is planted in rows. Repeat the procedure used for the dandelion distribution pattern to count and record another flowering plant of the students' choice.

Discussion questions:

How were dandelions distributed in nature? (Randomly)
How were flowers distributed in the garden? (Linear, regular)
Why do they have different distribution patterns? (Natural distribution vs. gardener's preference to set out in straight rows)

Follow-up:

Plot distribution patterns for other plants in other places, such as the edge of a sidewalk. Discover still other distribution patterns (e.g., plantain may be distributed within a short distance from the walk).

WEED HABITATS AND DIVERSITY

Objectives:

To measure plant distribution in different kinds of environmental conditions.
To compare the plant diversity of a lawn, field, and a disturbed area.

Materials:

Measuring device (e.g., hoop or metal clothes hanger bent into a circle)
Paper and pencil

Introductory questions:

Do the same kinds of plants grow in a lawn, a field, and on disturbed ground?
Do as many different kinds of plants grow in each of these places?

Procedure:

Using a measuring device, randomly choose 10 plots on the school lawn. Tossing a hoop will obtain random samples.
Identify or sketch weeds in each plot. Count and record.
For each weed, add the number found in each plot to obtain the total number of that particular weed found in all 10 plots.
Repeat the procedure for a vacant lot in the neighborhood.
Repeat for a gravelly area, parking lot, etc.

Discussion questions:

Do the same plants appear in each plot?
Why are some present in some places but not in others?

Follow-up:

Determine the relative diversity of each plot. Use the formula:

$$\text{Diversity} = \frac{\text{total number of individuals}}{\text{square root of the total number of species}}$$

The area with the largest diversity value is the most diverse.
Discuss why one area might be more diverse than the others and what are the advantages to a diverse system. (Stability)

SUCCESSION ON THE SCHOOL LAWN

Objectives:

To learn the concept of succession.
To recognize succession in process.
To observe succession taking place on the school lawn.

Materials:

Fencing (enough to enclose chosen area)
Perennial grass seed
Lawn mower (borrowed)
Paper and pencil
Weed identification book (optional)

Introductory question:

What changes take place when disturbed ground is allowed to grow plants naturally?

Procedure:

Locate a plot of the school yard that has recently been disturbed (by planting, building, or overuse).
Fence it off. Divide it in half.
Plant half with grass seed. Keep it mowed and watered as necessary.
Allow other half to grow naturally.
At weekly or monthly intervals (as appropriate), note and record the condition of the plot.
As weeds grow, identify or sketch each; add date of first appearance. Record data for each half of the plot separately. Continue to note new plants as they appear and also when they are no longer seen. (It may be weeks or months before students become aware of a species' disappearance.)
Plot a chart for each half of the plot with a vertical axis listing the plants growing in the plot and the horizontal axis indicating dates. Plot when plants appear and when they no longer exist in that area.

Discussion questions:

How did the two plots differ? Why did they differ?
Which plants appeared first in the natural plot? Did they remain?
Were they still there after a year? two years? three?

Follow-up:

Follow with "Where Weeds Grow" and "Weed Habitats and Diversity."
As this activity will take at least one full school year, possibly two or three, it will need the cooperation of several teachers.

PLANT GROWTH IN TRAMPLED AREAS

Objectives:

To compare plant growth in trampled areas to that in relatively unused areas.
To discover which plants grow best in trampled areas.

Materials:

Paper and pencil
Weed identification book (optional)

Introductory questions:

What kinds of plants can grow even if they are stepped on?
Will these plants be different from those that are not walked on?

Procedure:

Find an area of the school yard that has been trampled (often at a sidewalk corner).
Identify or sketch plants growing in these areas. Count and record.
Look through the school lawn for examples of these plants. Is the same percentage found in trampled areas?
Carefully observe the plants growing in foot traffic areas. Discuss these questions:
Where do their leaves grow? (Usually directly from the soil, or from stems that creep vinelike along the ground)
How can this help them to adapt?
Carefully, step on one of them. What happens?
Then, very carefully, begin to step on another kind of plant. What happens to it?

Discussion question:

How are certain plants adapted to conditions that would kill or damage other plants?

Follow-up:

Define the term weed.
Find beneficial uses for weeds.

Chapter 6

Small Plants

SEEDS AND SPROUTS

Objectives:

To become aware of the diversity of seeds.
To learn that seeds produce plants.
To learn that specific seeds produce only specific plants.
To predict which plants will grow from certain seeds.

Materials:

Seeds
Pots (e.g., small milk cartons)
Planting soil (purchased, from home, or from the school yard)

Introductory questions:

Does one kind of seed always produce the same kind of plant?
How do plants grow from seeds?

Procedure:

In fall, collect a variety of seeds. Be sure that each student has at least one seed. Include acorns if possible, or other tree seeds.
Sketch seeds. Measure size and record with sketch.
Plant seeds in pots.
Keep moist, but not wet.
When seeds begin to sprout, place them on a window sill.
Sketch the seedlings as they grow and change.
Measure growth and record on the sheet with the sketches.
After the seedlings produce their second set of leaves, their "true leaves," compare these leaves.

Discussion questions:

Did all seeds sprout? Did they all live?
Did all seeds of one kind produce seedlings that looked alike (had the same kind of true leaves)?

Follow-up:

Repot plants for Mother's Day gifts.
Grow annuals (e.g., radishes, marigolds) and collect seeds.
Plant a second generation. Note that a particular plant always produces its own typical seed and that those seeds always produce only one kind of plant, although the flower color may differ.

LOOKING FOR SPROUTS

Objectives:

To strengthen powers of observation.
To categorize weed sprouts (plant seedlings) according to physical characteristics.
To be able to place small (probably unidentified) plants into groups based on characteristics.

Materials:

Paper and pencil

Introductory questions:

Where can we find sprouts?
Why would we expect to find them in certain places?
Why would they grow there?

Procedure:

In spring, form small teams to look for sprouts.
Check places such as between the edge of the lawn and the school building, in sidewalk cracks, at edges of plantings, and at corners of sidewalks.
Sketch the types of sprouts found. Label where they were found.
Count and record the number of each kind of sprout growing in each location.

Discussion questions:

Where do sprouts grow?
Do certain kinds of sprouts seem to prefer certain locations to others?
What seem to be the most favorable habitats for new plants?

Follow-up:

Follow with "Tree Productivity" and "Weeds in a Crack."

MOSS MEASUREMENT

Objectives:

To discover whether moss can be used as an accurate indicator of direction.
To gather information by a random sampling method in order to test a hypothesis.

Materials:

Moss marker
Paper and pencil
Compass
Graph paper
Clipboard

Introductory question:

Does moss grow only or grow best on the north side of trees?

Procedure:

Prepare a moss marker:
- Cut a 1-yd. (or 1-m) piece of webbing (belt backing, 2" wide ribbon, etc.).
- Punch holes every 2 in. (5 cm).

Do field work:
- Choose 10 trees to study.
- Using a compass, find the four directions, north, south, east, and west, on the trunk of a tree.
- Place the moss marker on the north side of a tree with the end of the marker touching the ground. It should be vertical along the trunk of the tree. Have one student hold the top of the marker steady and another hold the bottom.
- Count and record the number of holes through which moss can be seen.
- Repeat for the south, east, and west sides of the tree.
- Repeat all steps for the other nine trees.
- Add together the moss counts for the north sides of all 10 trees to obtain a total. Repeat for the south, the east, and the west sides.

Make and use a moss-rose:
- Draw an intersecting vertical line and horizontal line through the center of a piece of graph paper.
- Mark the ascending vertical North, the descending vertical South, the right horizontal East, and the left horizontal West.
- Determine scale, e.g., 1 square inch of graph paper = 10 moss sightings.

Count and mark the number of moss sightings for each direction.

Observe chart. It will probably look like a kite.
Is this visual evidence proof that moss can be used as an accurate indicator of direction?

Discussion questions:

Does moss grow only on the north side of trees?
Is moss on trees a good way to tell direction?

Follow-up:

Follow with other activities requiring random sampling.

MOSS FORMS

Objectives:

To investigate a miniature world.
To recognize that even tiny plants exist in a wide variety of forms and shades.
To discover the forms and shades of moss.

Materials:

Hand lenses (one per student)
Paper and pencil
Coloring supplies (e.g., crayons, paint, or pastels)

Introductory questions:

What do moss plants look like?
Are they all the same?
How many kinds can you find?

Procedure:

Using a hand lens, examine a moss plant (usually found on trees or shady soil).
List words to describe the leaves (e.g., leafy, fuzzy, fern-like, luxuriant, starry, bottle-brush - shaped).
Make a sketch of the plant.
Color the sketch.
Find another plant and repeat.
Compare words, sketches, and shades of green found by class members.

Discussion questions:

How many different forms of moss could you find?
How many did the entire class find?
How many shades of green can mosses have?
What words did you use to describe moss?

Follow-up:

Prepare a bulletin board display using colored sketches of moss and words used to describe them.
Write stories and poems about tiny animals that could live in the moss.

Chapter 7

Experiments with Plants

THE EFFECT OF LIGHT ON GRASS

Objective:

To learn how the absence of light can affect plant growth.

Materials:

Heavy piece of cloth

Introductory question:

What happens to grass if it does not get enough light?

Procedure:

Cover a small plot of lawn with a heavy piece of cloth, such as canvas.
Leave for a week.
Observe the color of the lawn when the canvas is removed.
Place the canvas on another plot of lawn.
Observe the times required for grass to lose and to regain its color.

Discussion questions:

What happens to the lawn's color when it is deprived of sunlight?
How long does it take for the lawn to recover its normal color?
Which takes more time, losing or gaining color (and health)?

Follow-up:

Observe shady and sunny lawns. Which have the best grass growth?

FERTILIZING AQUATIC SYSTEMS

(Rainy-Day Activity)

Objectives:

To discover how fertilizers can enhance plant growth.
To conduct a controlled experiment in order to draw conclusions.

Materials:

Several small jars with lids
Fertilizers, including liquid detergent, household ammonia, and miscellaneous fertilizers

Introductory questions:

How can we make algae grow in water?
What affects the growth of plants in water?

Procedure:

Collect water from a nearby pond, stream, or puddle.
Place equal amounts of water in jars.
Cover one of the jars, label it "control," and set aside.
Add detergent to several jars as follows: one drop to the first, two to the second, three to the third, etc. Label.
Add household ammonia to some of the other jars as follows: one drop to the first, two to the second, three to the third, etc. Label.
Add fertilizer to the rest of the jars as follows: 1/2 tsp. to the first, 1 tsp. to the second, 1-1/2 tsp. to the third, etc. Label.
Set all jars in the same location, one with some daylight.
Observe for several weeks. Note any changes taking place in the jars. Record.

Discussion questions:

Do plants grow at the same rate in all of the jars?
Do plants grow faster or more abundantly in some of the jars?
What seemed to affect growth?
Did water with larger quantities of detergent or ammonia grow more algae? (Both will act as fertilizers at low concentrations.)
Did water with larger amounts of fertilizers grow more algae?

Follow-up:

Observe algal blooms and growth in local ponds and streams.
Discover sources of fertilizer to the waters (e.g., yard or park runoff, sewage treatment plants).
Draw conclusions regarding fertilizers added to the water and plant growth.

Discuss how a body of water can be prevented from aging (becoming choked with unwanted plant growth) too rapidly.

Read about eutrophication in natural waters.

Prepare an advertising campaign to decrease the addition of fertilizer to a local body of water.

49

THE EFFECT OF LIGHT ON PLANT GROWTH

(Indoor Activity)

Objectives:

To observe and chart plant growth.
To learn the effects of colored light on plants.

Materials:

Five mini-terrariums (See "Making Mini-terrariums and Mini-aquariums," Chapter 13)
Charcoal
Dirt
Seeds (e.g., radish or marigold; use the same in all terrariums)
Colored cellophane: red, blue, green, and yellow

Introductory questions:

Which color of light makes plants grow tall? sturdy? fast?

Procedure:

Prepare five mini-terrariums according to instructions in "Making Mini-terrariums and Mini-aquariums."
Plant several fast-growing seeds in each.
Provide each with the same amount of light and water.
Wrap one in each of the colors of cellophane; leave one unwrapped.
Place all in a window. Provide sufficient water.
Observe and chart plant growth.

Discussion questions:

Which color produced the tallest plants?
Which color produced the strongest-looking plants?
Which flowered first?
What color are the plants when the cellophane is removed?

Follow-up:

Discuss these questions:
- What effect might "red" sodium vapor lights, which produce a pink light, have on trees near them?
- Might pollution that changes air color affect plant growth?

Part Three

Animals in the City

Chapter 8

Overview

WILDLIFE HIKE

Objectives:

To become aware of and familiar with wildlife in the immediate area.
To learn where to look for urban wildlife.

Materials:

Paper and pencil (optional)

Introductory questions:

What kinds of animals do people usually study? List.
Where are they usually found? (Field and forest)
What kinds of animals can be found in the city? List.
Where can people look for animals in the city?

Procedure:

Copy the list of urban animals and distribute to the class.
Work in teams or as an entire class group. Designate a student to act as recorder for each group.
Take a 15- to 20-minute observation walk around the school block. Be sure that no classes have recess or other outdoor activities at the same time.
Walk quietly, being careful not to frighten any animals.
Ask awareness questions, such as:
- Do you see any birds?
  - What are they doing?
  - Do you hear their calls?
  - How would you describe their calls?
  - How do they look?
  - Do you know any?
- Can you find any insects on the sidewalk? In the lawn or dirt?
  - How would you describe them?
  - What are they doing?
- Can you find any mammals (furry animals)?
  - What are they doing?
  - Do you know any of their names?

Discussion questions:

What animals were found from the list of animals which the class expected to find?
Can we find wildlife in the city?
Shall we look for more?

Follow-up:

List where more city animals might be found. Look for them.
Record the animals found, where they were, and what they were doing.
Follow with "Basic Bird Observations" and "Sidewalk Wildlife."

Chapter 9

Birds

BASIC BIRD OBSERVATION

Objectives:

To develop the ability and patience to watch birds.
To begin to learn about bird behavior.

Materials:

(All optional)
Binoculars
Bird identification book
Paper and pencil

Introductory questions:

How do birds differ in their actions? How are they the same?
How do they differ in their reactions to each other and other creatures, including people? How are they the same?

Procedure:

Find a comfortable spot in which to sit or stand.
Observe birds for 15 minutes. Try to answer questions such as:
- What are they doing?
- What are they eating?
- Do they seem to talk?
- Are they sociable with each other?
- How do they react to people?
- Do they respond when they are talked to? (This is especially noticable with pigeons.)

Discussion questions:

Which birds were viewed the most frequently?
Which birds seemed to be the boldest? Why?

Follow-up:

Write a fantasy story about birds watching people.
Follow with other bird activities.

SYMPHONY OF THE BIRDS

Objectives:

To distinguish between the calls of different birds.
To be able to recognize different types of calls.

Materials:

Paper and pencil (optional)

Introductory questions:

How many different birds are calling around the school?
How many different bird calls can you distinguish?

Procedure:

Listen to bird calls for five minutes. How many kinds of calls does each student hear?
Describe calls or imitate them. It is not necessary to be able to identify calls at first, just to distinguish the differences auditorily.
If students want to try to identify calls, begin with common, easily recognized calls of robins, crows, jays, sparrows, grackles, and pigeons.

Discussion questions:

How many different calls were heard?
Do calls seem to be for different purposes (e.g., happy singing, alarm, chattering)?

Follow-up:

Read about why birds make different calls.
Write a story about why birds are making different calls.

BIRDS PREPARE FOR WINTER

Objectives:

To observe and learn how birds prepare for winter.

Materials:

Paper and pencil
Bird identificiation books
Binoculars (optional)

Introductory question:

How do birds prepare for winter?

Procedure:

Observe bird activity in fall. This may be done in the school yard or through a classroom window.
Discuss which birds:
- Change their songs.
- Seem to become bolder, and come closer to buildings and people.
- Gather in flocks, and:
  - Become noisy, all chattering at once.
  - Fly in flocks, then settle into the trees again.
  - Fly in formation.

Discussion questions:

How do birds prepare for winter?
Do different birds prepare in different ways?

Follow-up:

Observe and record when migrating birds leave.
Observe and record when winter residents begin eating at feeders.
Follow with "Bird Behavior at Feeders."

BIRD BEHAVIOR AT FEEDERS

Objectives:

To observe bird behavior and recognize the behavior of different birds when feeding.
To discover favorite feed of different birds.

Materials:

Several kinds of bird seed (e.g., mixed seed, sunflower seed, peanut butter mixed with cooking greases and crumbs, suet)
Binoculars
Identification books
Paper and pencil

Introductory questions:

What do birds eat in winter?
How do they act when they are eating?

Procedure:

Make or purchase several bird feeders and several kinds of bird feed.
Hang and fill feeders. Keep filled.
Make daily observations of birds at and around feeders.
Note time, species, food eaten, reactions to other birds of the same and of different species and to humans.
Observe to find answers to the following:
Which birds eat alone? with others of the same species? with birds of other species? Do some seem to wait their turn? Which birds chase off birds of their own or other species? What is the sequence of birds at a feeder?
Which birds eat one seed at a time? Which eat at the feeder?
Which remove the feed to eat it? Which eat messily?
Which birds sit at the feeder? Which cling to its sides?
Which eat upside down? Which perch on a branch to eat?
Which eat on the ground?
Collect the debris on the ground under feeders. Examine to determine which bits are shells and which are entire seeds.

Discussion questions:

Do birds have different tastes in food, as people do?
Which food does each species of bird prefer?
What food is wasted?

Follow-up:

Calculate which feed is a better buy. Subtract the amount of feed wasted from the total amount placed in the feeders. Calculate the price per unit eaten.

Plant a birdseed garden of the birds' favorite seeds. Harvest and use next year.

Make a booklet of birds and their favorite foods. (Younger children may make it for themselves, older children for younger ones to read.)

NESTING BIRDS

Objectives:

To enjoy the experience of observing nesting birds.
To gather information on nesting birds.

Materials:

Bird identification book
Binoculars (optional)
Paper and pencil

Introductory questions:

When do birds build nests?
What materials are used in nest building?
How long does it take for young birds to mature and leave the nest?
Which parent takes care of the baby birds?

Procedure:

Find a pair of nesting birds close enough to observe.
Watch for the following information:

- Nest building
  - Division of labor (which bird does which job)
  - Materials for the nest and their sources
  - Way the nest is held together
  - Building techniques
  - Time needed to build the nest
  - Size of the nest when completed
- Eggs
  - Number, size, color, and shape
  - Incubation time (how long till they hatch?)
  - Is there always a parent bird on the nest?
  - Which parent does the incubating?
- Baby birds
  - When do they hatch?
  - Do all hatch at once? within a day?
  - How long do they live? Do some die young?
  - How often are they fed? Count the number of times they are fed in 10 minutes.
  - What do they eat?
  - Which parent feeds them?
  - When do they leave the nest? This may happen in summer.
  - Compare the size of baby birds when they leave to that of the parents.

When do all of the birds, parents included, leave the nest?

Discussion questions:

What new knowledge have you gained regarding nest building? eggs and incubation? baby birds and their parents?

Follow-up:

Discuss how bird families are similar to human families and how they are different.

Learn whether parent birds return to the same nest the next year. This may be discovered by waiting until next year and watching or by reading books on bird behavior. If they do not, nests can be collected to use as follows:

First, place each in a jar and fumigate* it.

Next, place each on a screen and gently shake out dead insects.

Display.

Dismantle and categorize building materials.

Try to build a bird's nest using similar materials.

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*Soak a cotton ball in carbon tetrachloride. Place in the bottom of the jar beneath the nest. Cover the jar for at least one hour. CAUTION THE STUDENTS NOT TO BREATHE THE FUMES.

Chapter 10

Insects and Other Small Animals

SIDEWALK WILDLIFE

Objectives:

To become aware of the diversity of animals that live on a sidewalk.
To discover relationships between environmental conditions and animal activity.

Materials:

Thermometers
Anemometers
Light meters (optional)
Paper and pencil

Introductory questions:

What animals have been seen already?
Which ones might be found on a sidewalk? (Careful, quiet observations can reveal many things that are often overlooked.)

Procedure:

Make 10-minute observations two or three times daily.
Have each student choose his/her own sidewalk square.
Observe small animals, e.g., insects, spiders, daddy-longlegs, found on that square only. Identify or sketch them. List, count, and record those found.
Observe and record weather conditions, including precipitation.
After each observation, compile data on each species found.
Continue observations for a month at a minimum of twice daily, one day per week.
Chart on overlays the insects found and weather conditions.
Visually observe relationships between weather and insects.

Discussion questions:

Do insects prefer warm or cool weather? windy or still? humid or dry?
Are some insects active under more varied conditions than others?

Follow-up:

Follow with "Micro-climates" and "Mini-habitats."
For older students, do a simple correlation between temperature and number of insects that are active.

INSECT DISTRIBUTION PATTERNS

Objectives:

To learn where insects may be found.
To learn methods of capturing insects.
To place insects into broad categories.

Materials:

Paper and pencil
Nets (optional)
Identification books (optional)
Study jar with lid

Introductory questions:

Where do insects live?
Where would you expect fo find ants? butterflies? bees? others?

Procedure:

Look for insects in a variety of locations, such as lawns and weeds, trees and shrubs, sidewalks and dirt, and walls of buildings.
Use several techniques:
Sit and look quietly (sidewalk and dirt; building wall).
Lift bark, leaves, etc. (trees and shrubs).
Use an insect net. While taking 10 steps, sweep the net back and forth 10 times just below the top edge of the grass or weeds; quickly fold the net shut; transfer insects into a study jar by hand (lawn and weeds).
Place insects into broad groups, depending on observable characteristics such as showy wings, shell-like wings, two wings, large legs for hopping, and others, as appropriate.
Count the number of insects of each group found in each location.
Allow insects to go free outdoors.

Discussion questions:

Where were most insects found?
Why were insects found in these places? cover? food? sunlight?

Follow-up:

Read about the insects that were found and their habits.
Use the diversity formula in "Plant Distribution Patterns" in Chapter 5, "Weeds and Grass", to determine insect diversity in areas sampled.

ACTIVITY IN AN ANTHILL

Objectives:

To follow ant movement patterns.
To experiment with ants' ability to sense food.

Materials:

Food crumbs
Honey
Water
Jars
Petri dishes or margarine tub tops
Paper and pencil

Introductory questions:

Have you ever watched an anthill and wondered where all of the ants are going? What they are doing? What they eat?

Procedure:

Find an active anthill.
Locate ant pathways; watch ant movement for a few minutes. Do they seem to follow certain pathways, or do they move about randomly?
Experiment with food:
- Place a crumb of food in a pathway.
  - Do the ants remove the crumb? How do they do it? Do they work together or separately? Does one ant work individually?
  - If the crumb is too large for one ant to handle, does it seem to contact other ants to help, or do others just arrive on the scene and help? Do they cooperate? Where is the food taken?
- Add a drop of honey to a cup (1/4 l) of water. Pour a little into a margarine tub top. Place it a few inches away from any runway. Do the ants notice the honey solution? Watch for a few minutes.
- Double the concentration of honey--two drops per cup (1/4 l). Repeat.
- Continue doubling the concentration until ants notice the honey and come for it.

Discussion questions:

Do ants follow runways in their work?
How do ants manage to move food particles that are too big for them?
In what ways are they similar to or different from people?

At what concentrations can ants recognize the scent of a honey solution?

Follow-up:

Calculate the concentration of honey that ants noticed.

Count the number of drops required to fill a tablespoon. Multiply that number by 16, the number of tablespoons in a cup, to determine how many drops are in a cup.

Example: If 40 drops fill a tablespoon, 40 x 16 = 640 drops in a cup. (Count the number of drops required to fill a 10-gm measure. Multiply that number by 25, the number of 10-gm measures in 1/4 l, to determine how many drops are in 1/4 l.)

Write the concentration noticed by ants as a ratio.

Example: If ants notice 4 drops of honey in a cup of water, the ratio is 4 : 640, which can be reduced to 1 : 160. (Express the ratio as the number of drops noticed to the number of drops in 1/4 l.) A solution of 1 : 160 can be recognized by ants as honey.

Note: Measurements will vary.

Experiment with concentrations of honey that children can notice. Compare to the concentrations sensed by ants. Which have a stronger sense of scent? Does this help ants in survival? What other means do people have for finding food?

Make an indoor ant farm:

Carefully dig up part of an anthill.
Place into a peanut butter or mayonnaise jar.
Fill to within 2 in. (5 cm) of the top.
Place a screen over the jar top.
Add food daily.
Observe.
Place the jar in a dark place or against a wall. After a few days, observe tunnel building.
Release the ants outdoors after the students' curiosity has been satisfied and questions answered.

INSECTS AND FLOWERS

Objective:

To discover which insects prefer which particular flowers.

Materials:

Flower and insect identification books (optional)
Paper and pencil
Crayons, colored pencils, or pastels

Introductory question:

People prefer certain foods to others. So do dogs and cats. Squirrels and birds do, too. How about insects?

Procedure:

Have each student choose a flower to observe. Be sure that each kind of flower in the garden, lawn, lot, or field is chosen.
Observe for 15 minutes. Record observations.
- Sketch the flower. Note its color.
- Identify or sketch each insect that visits the flower.
- Record how long each insect stays.
- Record what each insect does.

Chart the flowers and the insects found at each.

Discussion questions:

Do insects seem to have preferences for certain flowers?
Which insect visits which flower?
Does flower color seem to affect the number of visiting insects?

Follow-up:

Make a bulletin board with sketches of flowers and the insects that visit them. Place as many insects around each flower as were actually found there.
Read about insects and flowers. How do they help each other?
Write a story about an insect looking for flowers.

COLLECTING CATERPILLARS

Objectives:

To learn which plants are food for caterpillars.
To discover which butterflies and moths come from captured caterpillars.

Materials:

Jars with diameters of at least 3-1/2 in. (8cm) with lids, one per caterpillar

Introductory questions:

How do caterpillars change to butterflies and moths?
What food do they eat as caterpillars?

Procedure:

In late summer and early fall, collect caterpillars and cocoons/chrysalises. Look on weeds, shrubs, and trees; monarchs are found on milkweed, swallowtails on carrots or dill.
Caterpillars must be fed daily, and will probably eat leaves from the plant they were found on. To be sure, check a guide book for positive identification and the food they require.
Place each caterpillar or cocoon/chrysalis in a separate jar. Label jar with name and diet.
Poke several holes in the covers of the jars before closing them.
Clean jars and feed fresh leaves daily.
Observe eating patterns:
Do they eat the entire leaf or only the margins?
Do they eat randomly?
Place cocoons/chrysalises in a window. If they are taken home, they can be taken out of the jar and placed between inner and storm windows.
In spring, when butterflies and moths emerge, recheck their identity.
Sketch and color.
Then release them outdoors and watch them fly free.

Discussion questions:

What kinds of food did each species of caterpillar prefer?
Do young butterflies and moths look like adults (as mammals do)?

Follow-up:

Write poems about released butterflies.
Post illustrations of caterpillars and corresponding butterflies and moths on the bulletin board. On another board, post students' baby pictures. Hold a contest to identify babies and students, caterpillars and adult insects. Are more children identified correctly than insects?

INSECTS PREPARE FOR WINTER

Objective:

To learn some of the ways in which insects prepare for winter.

Materials:

Paper and pencil

Introductory question:

How do some common insects prepare for winter?

Procedure:

Look for:
- Monarch butterflies and dragonflies migrating.
- Ladybird beetles moving to leaf litter, the bases of fence posts, and trees.
- Bees and wasps swarming.
- Flies hovering around the same side of a building.
- Box elder bugs coming indoors.
- Caterpillars and cocoons.

Listen for crickets, katydids, and grasshoppers.
When are their songs the loudest?
When are they last heard?
Record for reference in winter investigations.

Discussion question:

What are some ways in which insects prepare for winter?

Follow-up:

Follow with "Where Insects Hide in Winter."

WHERE INSECTS HIDE IN WINTER

Objectives:

To discover how insects spend the winter.
To learn that insects spend the winter in one of four life stages.
To learn that different insects spend the winter in different places and stages.

Materials:

Paper and pencil

Introductory questions:

What do insects do in winter when it is too cold for them to be outdoors?
Can we find some of their hiding places?

Procedure:

Look for insects in hiding places:
- Under tree bark
- In rotting logs
- In stumps
- At the bases of trees and fenceposts
- In leaf litter
- At the bases of shrubs and weeds
- In the earth
- In and between windows
- On south-facing slopes

Identify or sketch insects found in each location.
Count and record.
List environmental conditions where insects are found (e.g., sun, temperature, wind, humidity, snow depth).

Discussion questions:

Which species of insects were the most numerous?
Where were most insects found?
Why might they choose to spend the winter in these places? (Shelter)
What life stage, egg, larva, pupa, or adult, were most of the insects in?

Follow-up:

Prepare a large mural of the school yard.
Place pictures (sketches) of insects where they were found over-wintering.
Cover pictures of insects with pictures of their hiding places. Use as a quiz board.
Continue to observe insects' resting places in spring as they emerge.

DADDY-LONGLEGS

Objectives:

To discover similarities and differences between daddy-longlegs and spiders.
To learn to view daddy-longlegs as acceptable creatures.
To learn about the habits of these elusive animals.

Materials:

Bug boxes

Introductory questions:

What are daddy-longlegs?
What do they do?

Procedure:

Look for daddy-longlegs in the school yards. (Most will probably be on walls of the school building.)
Observe them in motion. How do they walk? Observe the waving motion of their front legs.
Pick one up. How does it feel? (Like a very light tickle)
Capture one or two in a bug box (to observe only).
- How many legs do they have? (8)
- How many do spiders have? (8)
- How many body parts do they have? (1)
- How many do spiders have? (2)

Observe their reactions to each other.
- What happens when two daddy-longlegs come into contact? Do they fight? Do they avoid each other?

Place small scraps of meat where daddy-longlegs are frequently found.
- Return at intervals. If some of the meat is gone, watch quietly to see if daddy-longlegs are responsible.

Discussion questions:

How do daddy-longlegs react to each other?
What do daddy-longlegs eat?
What animals do they seem to be related to?

Follow-up:

Have students locate daddy-longlegs in their own yards.
Place meat out for them. Observe at night with a flashlight.

EARTHWORMS IN THE AREA

Objectives:

To learn where earthworms live.
To learn how earthworms are helpful.

Materials:

Paper and pencil
Shovel (optional)
Electric light bulb (optional)

Introductory questions:

What is the main job of earthworms?
How are earthworms helpful to us and to nature?

Procedure:

In spring, identify the presence of earthworms by finding castings on the ground or tunnels.
After a rain, look for earthworms.
- Where are they?
- Why do they come out of their burrows?
- What would happen to them if the sun came out too suddenly?

Dig up a 4" x 4" square (1 dm x 1 dm square) of soil 2" (4 cm) deep.
- Count the number of worms in it.
- How many worms will be in a square foot (or meter)?
- How many worms could be found in the entire school yard? if the entire school yard were soil? in the area that is not blacktop or building?
- Each earthworm turns over 1 to 1.3 lb. (0.4 to 0.6 kg) of soil each year. How much earth is turned over in your school yard?

Discussion question:

In what way are earthworms helpful and valuable animals?

Follow-up:

Collect a few earthworms.
Place them in a box with soil at one end.
Shine a 60-watt bulb on them. What do they do? Where do they go?
Try adding a simple maze to the box. See if the earthworms can learn the maze.
Keep earthworms and soil in a jar in a cool place for a few days. Observe tunnelling activities. Return them to the school yard.

Chapter 11

Mammals

MAMMALS PREPARE FOR WINTER

Objective:

To learn how mammals prepare for winter.

Materials:

Paper and pencil

Introductory question:

How do mammals prepare for winter?

Procedure:

Beginning in early fall, list mammals seen each day and the number of times each is seen. (Most of the mammals that can be viewed are dogs, cats, rabbits, squirrels, and field mice.)

Observe and record what the animals are doing.

Where do they go?

What do they carry?

How do they react to each other?

Discussion questions:

When are more mammals seen actively scurrying around outdoors? (Generally mid-October)

Why are they out then rather than earlier or later? (It is still warm enough to gather food, and it is late enough in the season to need to prepare for winter.)

What kind of activity are they engaged in? (Generally, food gathering, especially squirrels and mice)

Follow-up:

Follow with "Mammal Activity in Winter."

MAMMAL ACTIVITY IN WINTER

Objective:

To learn how mammals respond to winter.

Materials:

Paper and pencil

Introductory questions:

How do mammals act in winter?
How do they stay warm?

Procedure:

Observe mammals that are active in winter.
Pet cats and dogs are ideal.
- Feel their thick fur. Sink hands into it.
- Feel how warm they are under their fur.
- Does their fur make them seem fatter than in the summer? (It should, since they grow an extra layer of insulating hair to protect them against winter's cold.)

Look for field mice. Their presence can be revealed by the presence of 1 in. (2 to 3 cm) tunnels through the snow. Follow a tunnel. Feel that it is hollow. Follow its turns. Try to find places where the mice have stored food. If students are lucky, they may find a mouse at the end of a tunnel.

Tracks and droppings reveal where rabbits are in winter, although they are not often seen during the day.

Squirrels are probably the most interesting of all mammals to observe in winter.
- Where do squirrels live? (In trees)
- When squirrels travel from one place to another, where do they want to go? (To trees)
- Do they travel randomly, or do they seem to have specific routes that they follow? (Generally, they follow distinct routes, and will wear a path in the snow.)
- Do they come to bird feeders? What do they eat there? Do the birds want them there?
- Place some of their favorite food (nuts or corn) far enough away from a bird feeder not to disturb the birds, but near enough to watch.
- Enjoy watching them during the winter. They will provide endless animated activity.

Discussion question:

How do mammals adapt to winter?
How do they keep warm?

How do they compare to birds?
How do they compare to insects?

Follow-up:

In spring, brush pet cats and dogs. Why do they shed so much? (This is winter's insulation.)
Beginning in March, observe squirrel families. Young squirrels will be active with their parents.

Chapter 12

Adaptation

ANIMAL CAMOUFLAGE AND PROTECTION

Objectives:

To recognize the use of camouflage in animals.
To learn how camouflage helps animals.

Materials:

Paper and pencil
Crayons

Introductory questions:

Many woodland animals use camouflage. How do city animals use it?
Which city animals that you know use camouflage?

Procedure:

Observe insects on plants. For each that is found, record its color and the color of the plant. Crayons may help recording color.
Observe bird coloration. In spring, note the colors of nesting birds. Compare the colors of the males to the females.

Discussion questions:

Do many insects have coloring similar to the plants they live on?
How does this help them?
Will it protect them from predators?
Which birds are generally brighter-colored, males or females? young or adults?
Which birds look like their surroundings?
How does this coloring help birds (bird families) survive?

Follow-up:

Read about camouflage in the animal world.
Find photographs of well-known animals, like fawns, that use camouflage.

Part Four

Studying and Building Communities

Chapter 13

Building Mini-terrariums and Mini-aquariums

MAKING MINI-TERRARIUMS AND MINI-AQUARIUMS

Objectives:

To make terrariums and aquariums to use in class that are both free and unbreakable.
To recycle what would otherwise be trash.

Materials:

Clear plastic soft drink bottles (2-liter size)
Knife or scissors
Charcoal and dirt for terrariums

Introductory question:

How can you make your own personal terrarium or aquarium for no cost?

Procedure:

For terrarium:

Obtain one 2-liter clear soft drink bottle.
Carefully, pry off the colored base. Set aside.
Cut off the top 1/3 of the bottle, removing the entire tapered part. Discard.
Soak and remove label. Nail polish remover will loosen the glue.
Place 1/2 in. (1 cm) of charcoal in the bottom of the colored base.
Add 1 to 1-1/2 in. (2 to 3 cm) of soil (quantity does not include depth of charcoal.)
Add plants with their own soil.
Invert the bottle and insert the open end into the base.

For aquarium:

Obtain two 2-liter soft drink bottles.
Carefully, pry off and set aside the colored base of one of the bottles. Discard the bottle itself.
Cut off the top 1/3 of the other bottle, removing the entire tapered part. Discard.
Soak and remove label. Nail polish remover will loosen the glue.
Add water, plants, and animals to the bottle.
Cap with the base of the first bottle.

Discussion questions:

What can mini-aquariums and mini-terrariums be used for?
(Growing small plants from seeds)
(Experimenting with growing plants)
(Keeping pond water to watch for changes in small life)

What should mini-aquariums and mini-terrariums not be used for?
(Terrariums with animals)
(Aquariums with fish and other vertebrates)
Because mini-aquariums and mini-terrariums are sealed, they may be harmful to these animals which need oxygen.

Follow-up:

Use for "Mystery Terrariums" and "Mystery Aquariums" or any other terrarium or aquarium.

Note: These aquariums are not meant to contain fish or any other higher vertebrates which require considerable oxygen.

Chapter 14

Communities

MYSTERY AQUARIUMS

Objectives:

To become aware that living communities exist in many places.
To strengthen powers of observation.
To discover that aquatic communities exist in many places.
To discover that aquatic communities can be small as well as large.

Materials:

Mini-aquariums (or peanut butter jars)
Paper and pencil

Introductory question:

Have you ever seen tiny, moving things in a puddle and wondered what they were?

Procedure:

Make mini-aquariums (see instructions in preceding activity).
Collect water from a puddle, ditch, or any other available spot. Put in plastic mini-aquariums or peanut butter jars. Place in several locations--window, dark area, and anywhere else in the room.
Observe growth, especially of algae (green scum).
Chart days and amount of scum found (percent of jar filled with it) or anecdotal information (tiny threads, half-full, murky, etc.).
Collect samples from several locations. Place all in a window and observe growth.
Chart changes that take place:
Which plants come first? when? which animals? This change is called succession.

Discussion questions:

What changes take place in water samples?
Are there differences between life in samples from different sources?
Do plants come first? animals? why? (Animals need plants for food).
Do changes seem to continue to take place?

Follow-up:

Keep jars for several years. If they are in the light, they will continue to grow and change.
Collect water samples from other locations, including ponds and streams. Compare aquatic life found.

MYSTERY TERRARIUMS

Objectives:

To discover that plants need specific conditions to grow in.
To discover that plant communities will continue to reproduce themselves.

Materials:

Several mini-terrariums
Trowels

Introductory questions:

Do different kinds of plants need different conditions in which to live?
Do certain plants always grow together in specific places?
Why does a field always look like a field, a forest like a forest, etc.?

Procedure:

Prepare terrariums from 2-liter bottles (see directions on making terrariums).
Collect dirt from as many different locations as there are bottles. Include forest, field, marsh, garden, swamp, etc.
Remove all visible plants.
Fill the bottom of each terrarium (dark section) with soil from one area.
Do not water, but be sure that the soil in each terrarium has the same moisture as the plot where it came from.
Cover terrariums and place in a window.
Observe and chart plant growth.
When plants are large enough, identify them.

Discussion questions:

Did the same kinds of plants grow in each terrarium? (No)
Are terrarium plants the same kinds as those found in the places dirt came from? (Yes)
Where did these plants come from? (Seeds in the soil)

Follow-up:

Take temperature readings at each site. Compare. Feel soil moisture.
For upper grades, collect an 8 oz. (or 250 gm) soil sample. Heat 4 hours in 250°F. oven. Compare wet and dry weights. Chart.
Experiment with planting seeds (both wild and garden seeds) in a number of terrariums to be grown under different conditions: wet as well as dry, sun as well as shade, etc. Do different plants need different conditions in which to grow?

TREE WILDLIFE

Objectives:

To discover the variety of wildlife that calls a tree "home".
To learn what plants grow on trees.

Materials:

Paper and pencil
Magnifying lenses
Binoculars (optional)

Introductory question:

A tree can serve as the basis for many small ecosystems. What kinds of plants and animals grow on and around a tree?

Procedure:

On the ground around the base of a tree mark a circle that is 1 yd. (or 1 m) from the tree itself. Carefully examine the soil and litter for insects and other small animals. Identify and record.

Remove soil along a small section, 6 to 9 in. (15 to 20 cm), of root. Identify creatures found, count, and record.

Examine the first yard (or meter) of bark on the tree. Look for small animals. Identify, count, and record.

Follow insect trails on and around the tree. What insects made or use these trails? Where do they go? What do they do?

Examine leaves for insect damage, insect food, insect homes, and insect eggs and cocoons.

Have each student observe a tree for 15 minutes. Try to answer questions such as:

- What birds and flying insects seem to live in the tree?
- What mammals stay in the tree?
- In winter, what tracks lead from tree to tree?
- What animals use the tree's seed for food?

Using hand lenses, examine the tree for small plants (mosses and lichens).

Discussion questions:

What animals and plants call a tree "home"?
What benefits does a tree provide for animals?

Follow-up:

Develop a food chain using the tree and plants and animals found on it.

Look for "caves" on the roots and bark. Write stories about the animals that might live there.

ANIMALS USE TREES

Objective:

To discover how animals use all trees in general and certain trees in particular.

Materials:

Paper and pencil

Introductory questions:

How do animals you have seen use trees?
How do other animals use trees?

Procedure:

Divide into teams.
Have each team choose a tree to observe daily.
Have each team observe its tree for 10 minutes at least twice daily for a week.
Record animals found in the trees (include birds, insects, and mammals) and what they are doing.

Discussion questions:

What animals can be found in a tree?
What were they doing?
How did they use the trees? for food? shelter? nests? as a perch? as a place to hide in?
Which trees were used the most for certain purposes? Examples: large trees for nests, oak trees for squirrel food, fruit trees for insects.

Follow-up:

Read about trees and their uses to people.

MINI-HABITATS

Objectives:

To discover animals living in micro-climate areas.
To compare the activity of animals from different areas.

Materials:

Magnifying lenses
Pencil and paper

Introductory questions:

What environmental conditions do animals need?
What animals live in the dark? light? where it is dry? wet? warm? cool?

Procedure:

Locate protected mini-habitats--under a shrub, at the corner of a building, and at the base of a tree.
Observe and record the small animals found and what they are doing. Try not to disturb them.
Then take reading of environmental conditions--temperature, humidity, wind, and light.
List environmental conditions wherever a specific creature is found.

Example: In each location where ants are found, list temperature, humidity, wind, and light.

Which factors change? Which remain fairly constant?

Discussion questions:

Did some factors remain fairly constant for certain creatures? Those that do remain constant are probably necessary for the creature's survival. These are called limiting factors.
Did some species seem to exist under a variety of conditions? These creatures are very adaptable.

Follow-up:

Broaden observations to include larger animals. What do they need to live? Examples: squirrels need trees, pigeons need buildings, field mice need grasslands, and frogs need water.

POND IN A PUDDLE

Objectives:

To discover life in small places.
To see similarities between a puddle and a pond.

Materials:

Hand lenses
Paper and pencil

Introductory questions:

How is a puddle like a pond?
Can we find any life in a puddle?

Procedure:

Find a puddle that is several days old.
Look for small plants and animals in the puddle. Sketch them.
Take some to the classroom to identify; return to puddle.
Watch the puddle for high-water marks as the water evaporates.

Discussion questions:

What kinds of plants and animals live in a puddle?
How is a puddle like a pond?

Follow-up:

Return to the puddle after a rain.
Follow with "Mystery Aquarium."

FOOD CHAINS IN THE SCHOOL YARD

Objectives:

To learn what a food chain is.
To learn what a food web is.
To be able to construct a food chain or web.

Materials:

Basic plant and animal identification books
Bulletin board
Crayons
Scissors
String
Pins

Introductory questions:

Do our schoolyard plants serve as food for any animals?
What do our schoolyard animals eat?
What is a food chain? food web?

Procedure:

Compile a master list of plants and animals found in the school yard. Use the information from these activities:
- "School Yard Trees"
- "Where Weeds Grow"
- "Wildlife Hike"
- "Sidewalk Wildlife"

List which animals eat school yard plants.
List the main food of school yard animals.
With this information, prepare a food chain (which will become a food web).
- Place pictures of plants (food producers) and their names on the bottom of the bulletin board.
- 1/3 of the way from the bottom of the board, place the picture and name of an animal that eats one of the plants. Connect the plant and animal with string.
- 1/3 of the remaining space above that animal's picture and name, place the picture and name of an animal that eats the first one. Connect these two with a string.
- Close to the top of the board, place the picture and name of an animal that eats the second animal. Connect them with a string.
- A simple food chain may be:
  - Weed eaten by beetle grub.
  - Beetle grub eaten by young starling.
  - Young starling eaten by cat.

Choose another plant and repeat the process.
A second simple food chain may be:
Weed seed eaten by sparrow.
Sparrow eaten by cat.
At this point, some of the plants and animals are involved in more than one food chain.
Interconnected chains become webs in this way.

Discussion questions:

Which plants are eaten by the most animals?
If they were removed, what would happen to the food chain or web?
Would some other plant take over as the major food producer?
Which animals are eaten by the most other animals?
If they disappeared, what would happen to the food chain or web?
Would other animals then be eaten?

Follow-up:

Play food-chain games in which students assume the roles of plants or animals. Simulate the loss of one species.

LOCAL ECOSYSTEMS

Objectives:

To learn the meaning of the term, ecosystem.
To be able to recognize and identify several local ecosystems.
To describe the functions of an ecosystem.
To recognize the importance of diversity in an ecosystem.

Materials:

Paper and pencil

Introductory questions:

What plants and animals usually live together on our school grounds? in a field? in a park?
Do all plants and animals need the same conditions to live?
What is an ecosystem?

Procedure:

Divide into small teams.
Each team should locate at least one ecosystem in the neighborhood or in the school yard. If several groups identify the same kind of ecosystem, combine their data. (An ecosystem is a combination of plants, animals, and environmental conditions all functioning together. It includes interactions between living and nonliving parts. An ecosystem can often be described by referring to the major plant found in it, such as grassland, weedy field, bluegrass lawn, tomato patch, etc.)
List plants found.
List animals found.
Take readings on environmental conditions (e.g., amount of sunlight, temperature, rain, soil conditions).
Develop a food chain (refer to "Food Chains in the School Yard").

Discussion questions:

Compare ecosystems:
Which plants were found in them?
Which plants or animals were found in only one type of ecosystem?
Which plants or animals were found in many types of ecosystems?
Which types of ecosystems had a greater diversity?
Did those with a greater diversity of plants have more animals?
How many steps were identified in the food chain for each type of ecosystem?
What would happen to each system if the major type of plant were eliminated?
What would happen to the food chain?
Would some animals not be able to live there any more?
Which ecosystems would change the most by the disappearance of

a single species--those with much diversity or those with little?

Follow-up:

Compare the composition of a vacant lot with that of a nearby garden which has one or two kinds of vegetables in it.
Which would change the most if disease wiped out one of the major plants?
Compare this to a cornfield vs. a prairie.
Read about Dutch elm disease and the disappearance of elm trees from American cities.
What has been done since then to prevent this kind of problem from recurring?
Interview the city forester and other people old enough to remember the Dutch elm disease.
Discuss why diversity is important.